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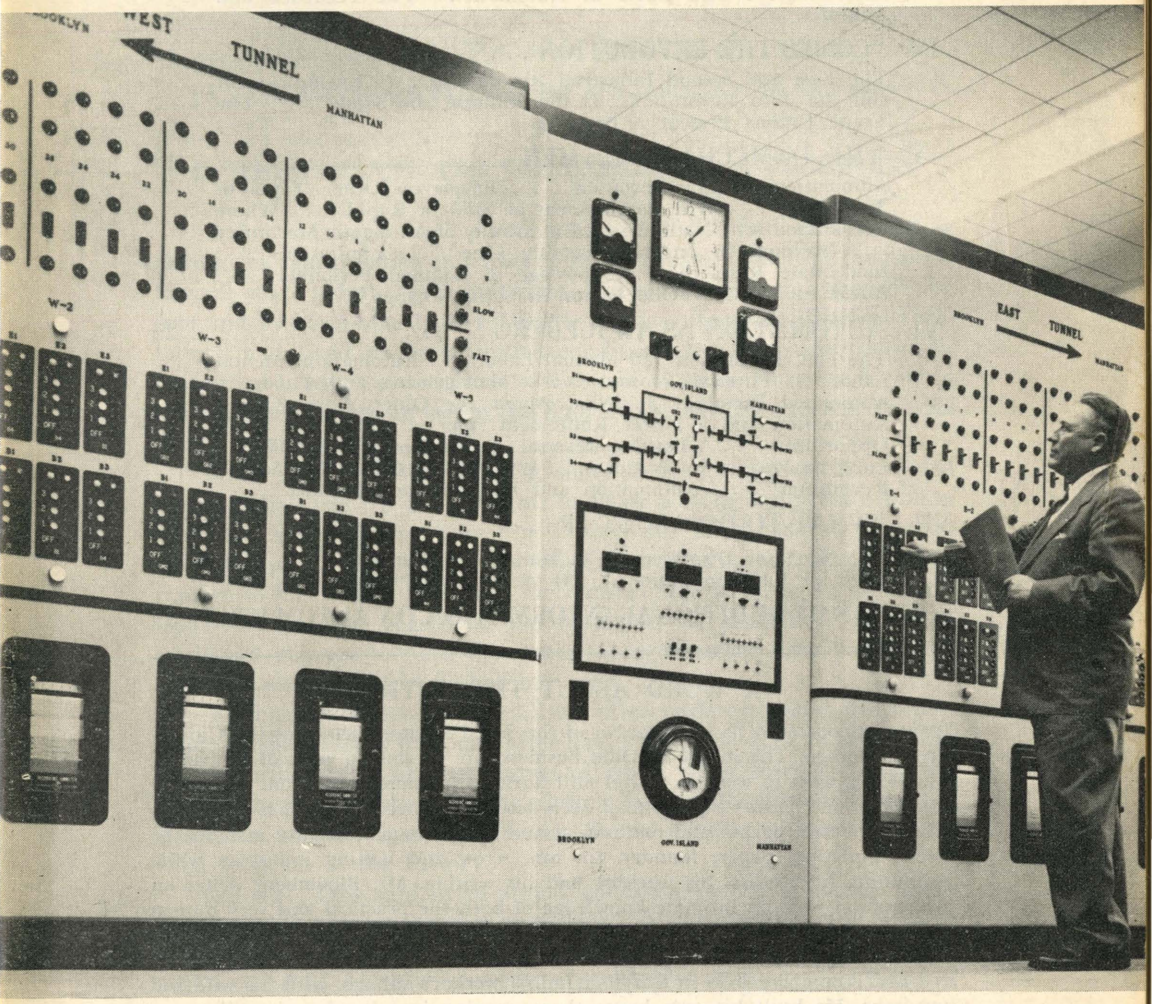
The age of automation, its effects on human welfare

Warner Bloomberg

THE AGE OF AUTOMATION

ITS EFFECTS ON HUMAN WELFARE

by WARNER BLOOMBERG, JR.



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A WORD ABOUT THE AUTHOR

WARNER BLOOMBERG JR. is a member of the Social Science Faculty of the University of Chicago. The son of an Ohio businessman. At sixteen years of age young Bloomberg went to work in a steel mill during his summer vacation. He was in the Navy for 2 years—a radar man on a destroyer. Since then he has worked as laborer, hooker, packer and mechanical and electrical maintenance man in the steel, tinplating, paper, foundry, tin can, screw and bolting industries while continuing his studies, his teaching and his writing. Mr. Bloomberg writes on Automation with an intimate knowledge of both the practical and very human aspects of this subject. He has written on Automation for the New Republic, Reporter and Commentary.

Mr. Bloomberg lives in Garyton, Ind., a worker's suburb, with his wife and two sons. He built his own house there, moving into it when it still was a windowless roof and shell.

The League for Industrial Democracy wishes to express its appreciation to Warner Bloomberg for his important contribution to the problem of Automation, a technological development which is sure to affect the future of this country, our lives and the lives of our children.

THE AGE OF AUTOMATION

Its Effects on Human Welfare

by WARNER BLOOMBERG, JR.

(A guide for the non-expert to the new technology of tomorrow)

I. THE PEASANT AND THE EXECUTIVE: A FOREWORD

A few years ago I met a young American who had gone to Russia during the late twenties and worked in a steel mill. He told this story. Several years before, Igor, a peasant, had made his way to the mill by foot and by hitch-hike from his native village where his illiterate forefathers had lived under primitive conditions for some ten centuries. So foreign to him was any form of mechanical production that he could not even be allowed to sweep the floor of the factory for fear that he would injure himself.

After Igor had been there a short time, the authorities decided that they had just the job for him: to sit on a stool and press a button whenever a light bulb above him flashed on. This, however, was too much for poor Igor. All that we take for granted in everyday life was foreign to him—measured time, mechanical repetition, and a standardized work routine geared to the regularity of machines. Igor just could not manage to push the button *every* time the light flashed on, and *only* when the light flashed on.

With a persistence we have all too often underestimated, the supervisors of the Russian mill, day after day, worked on Igor to adjust him to the mechanically oriented forms of work. After several months he pushed the button whenever the electric light bulb glowed. When the American arrived, Igor felt that he should explain to the newcomer what went on at the factory.

"You see", Igor said in an almost confidential tone of voice, "there are those big hills of red dirt over there. They bring that stuff in here and they make iron out of it." For Igor to understand that this great mill existed to transform ore into metal was a great step forward for him.

Perhaps this little story seems utterly irrelevant to the subject of "automation." But I always remember Igor whenever I recall an incident which occurred in a near midwestern town in this country only a few years ago. A progressive independent oil refinery had consolidated the controls for all its operations into one room, replacing the many separate stations from which workers controlling individual processes once communicated with each other by telephone and intercom.

It was an impressive, almost awe-inspiring, sight. Along one wall from floor to ceiling there was a graphic representation of the entire refinery—its towers, its pipelines, its meters and gauges which told what was happening from moment to moment as the refining processes proceeded. And on the board and adjacent stands and walls were the buttons, dials, and switches for controlling each of the processes.

On the day that the new system was officially put into operation, the president of the company told the workers and visitors who assembled in the room for a little "launching" ceremony: "You see how easy it is to make gasoline. You just put the crude oil in at one end," he said, pointing to one end of the long, mural-like wall, then, sweeping his hand to the opposite side, "and the gasoline comes out the other!"

This industrial executive's statement, which sounds so much like the Russian peasant's remarks to the American worker, was of course intended as a joke. The refinery president, long an oil man, understood every aspect of the refinery's processes. But he had only a slight knowledge of the principles and techniques employed in the creation of the new, almost automatic, control system.

Yet today each of us, expert and non-expert, is being urged to have an opinion about that most advanced form or controls for industrial production, while hundreds of articles have appeared in newspapers and magazines during the past two years warning the public that this new development can lead to massive unemployment or proclaiming that it will usher in a new "golden age" of plenty.

The plain truth, however, is that most of us have little more real understanding of automation than had Igor of his steel mills or than the oil executive pretended to have of the new control system at his refinery.

The purpose of this pamphlet is to increase the amount of common sense and understanding which we can bring to bear on the problems which are likely to accompany the advance of automation.

II. CAN A MACHINE THINK?

That uneasy thoughts have entered the minds of many of us regarding the effects of automation is not surprising when we consider the achievements of a few automatic devices featured in news stories today.

In one modern bakery, we are told, twelve automatically-controlled ovens are capable of producing sixty million crackers in an eight-hour shift. In another factory engine blocks are handled from start to finish by automatic machines. One of the devices applies 1,344 cutting instruments and, like the others, automatically signals a "machine tender" or maintenance worker when any of the tools is nearing the point at which it will no longer provide the required accuracy. In one ordance plant, bars of metal go in at one end and emerge as finished shells at the other; machines only handle the material along the whole production line.

Offices also have made increasing use of such devices. A corporation which sells electricity is using a machine which compiles all the information that goes into its nearly two million accounts, and prints these accounts by name twice a month. A great steel mill is turning its payroll accounting over to an "automated" system which will take the punched time cards of each worker for each week and calculate his earnings and take home pay, taking into account the overtime rates, different rates on his different jobs, and all the various deductions that must be made. Eventually it will carry the operations all the way through to making out the checks.

The question often asked is: "Do these machines really think"? To carry on their work, the mechanical and electronic giants which are appearing in increasing numbers must be able to perform certain kinds of activities we often characterize as thinking. They must be able to receive information about their goals, the means of achieving them, and the degree of of success they are attaining. These devices have to be able to remember and to choose the best course to take among various alternatives; in other words, to engage in the process of evaluation.

The "Thinking" of the Electronic Eye

Actually, we are surrounded by all kinds of "automatic" devices which carry on bits and pieces of the total process of thinking. For example, the electronic "eye" at the exits of the most modern supermarkets, in cooperation with simple motors, opens the doors for customers. The door appears to "see" the oncoming customer and opens when he approaches.

What really happens, of course, is that the body of the customer casts a shadow across a photo-electric cell, which sends an impulse to the motor, turning it on. The motor opens the door and is turned off by a simple switching device which operates as soon as the door reaches the wide-open position. And the door may be held open for a stated length of time or until a photo-electric cell on the outside passes along the information that the customer is safely outside.

This is activity about on a par with the mental machinations of the ant. It is strictly an either-or-proposition of the simplest sort—a thing that is basic to all of the devices comprised by that ambiguous label, automation. Either the object the ant approaches is food or it isn't; either the other ant approaching the same piece of food or non-food is one of the gang or an enemy agent.

In the same way, the device which automatically opens and closes the door can only perceive and react to the information that the customer is on his way through. It cannot tell if the customer is short or tall, fast-moving or slow, loaded down with groceries or carrying only one small artichoke. Nor can it tell if he or she is a charge-account, a cash sale, or a deadbeat.

The Feedback and the Thermostat

Most of us are familiar with automatic devices capable of much more subtle perception and performance. Some air-conditioned homes have both inside and outside thermostats and also include humidity controls.

In such a heating system the furnace has one built-in standing order—provide the degree of temperature in the house that corresponds to the amount of warmth requested by the inhabitants when they set the thermostat. The temperature-sensitive part of the inside thermostat feeds back into the systems information as to how warm is the air in the room where it is located. The outside thermostat in effect warns of future possible increase or decrease of inside temperature because of changes outside the house. The humidity control feeds into the system, to a humidifier connected with the furnace, information about how moist the air in the house is, a factor which affects how warm or cool the inhabitants feel at any given temperature.

This "feedback" is a crucial part of any self-regulating system of machinery. Many ordinary thermostated systems have noticeably ups-and-downs in the temperature and humidity level because they receive less information than the one just described. While every system for transmitting information, human and machine, tends to lose some information in the process, the flaws in a heating system could in large degree be overcome if the system were so constructed that all the necessary information were fed into it, continuously analyzed, and reacted to almost immediately by extremely sensitive machinery.

The Art of Remembering

We take for granted, then, devices which are capable of precise and subtle perception of selected elements in their environment. We are increasingly used to mechanisms capable of comparing their work with the goals they aim at, through feedback. And we are all acquainted with machines which "remember," although we usually do not apply that term to their activity. The moving picture camera and film retains images of ongoing events far better than human "memory," and the phonograph, the dictaphone and the tape recorder do the same with sounds.

Can such remembering be produced in a form usable by automatic machinery? All automatic machinery has, in one sense, a very low order of "memory" built into the mechanism itself. This is in the form of a simple reflex—a standard response to the same stimulus, whether it is the arrival of a customer at the exit door of the super-mart, or a drop in room temperature. But we are interested in the much higher ability to remember what the machine itself observes or what it is "told" by the human being for whom it is in a very real sense a near-perfect "slave."

The electronic calculator, within limits, can accomplish this feat. The limits are a consequence of the fact that the machine is absolutely logical. Any information—perceptions or instructions—which can be translated into a form that can become part of a mathematical formula can be retained in the electronic "memory banks" of these computers. This means that some pretty complicated kinds of information may be "remembered," since even a fairly profound policy decision, if it is thoroughly logical, can be analyzed down into its simplest component parts, each of which amounts to saying: "Two and two equals four."

"Programming" the Problem

When asking such a computer to undertake a task, it is necessary to instruct it as to the kinds of data it is supposed to use and the ways it can make use of that information. This is true whether the task is to solve a complex mathematical problem or control a complicated production line.

It is almost impossible to exaggerate how difficult this "programming" or taping of the problem can be. A computer has been used to translate several sentences of Russian into English. It did the job in a few seconds—after months of time put in by human experts "programming" the operation. The normal industrial problem is simpler than this, because it deals with elements and relationships which are distinct and clear in definition, unlike most of what we say and write!

The "Automatic" Stove

One of the nicest gadgets we have around today that combines some of the components of an automated system of production is the "automatic" stove——the gas or electric range with all those buttons and dials on it which have provoked cartoons and jokes suggesting the housewife would need a pilot's license to operate it. Suppose Mrs. Jones wants to roast a chicken for dinner, but also wishes to attend a club meeting at which a guest lecturer will discuss the impact of automation on family life in America! She stuffs the bird, wraps it in foil, and puts it in the oven. By pushing certain buttons and turning certain dials, she "programs" the stove so that, at just the right time, it will turn itself on and cook the bird at a high temperature for a given length of time, then automatically cook for a set period at a lower temperature, and finally turn itself off.

A combination of relatively simple timing, switching, and heat control mechanisms handle the on-off and temperature-change aspects of this performance. And Mrs. Jones' "automatic cook" uses a feedback system similar to the thermostat already described to maintain an even temperature of the desired degrees in the oven during each of the two different roasting periods. But it was up to Mrs. Jones to know at what temperature a bird of its size and characteristics should be roasted. Could she be relieved of some of these decisions with the aid of a calculator and additional devices for observing what was happening to the bird in the oven?

If we relax our demands for technical accuracy a little and limber up our imaginations, we can create just this kind of "thinking stove" in a fantasy which is not too far from the actuality of automation—a "stove" to which one can say, in effect, "Roast me a three-pound chicken," and then leave the rest to the machinery. Out of the freezer via a conveyor-belt system would come a bird of the correct size. At the stuffing machine it would be joined by pre-prepared dressing (probably preserved by radiation) and thence it would proceed into the stove. After being roasted to perfection, it would be grasped by a transfer device and placed upon another conveying system which would hand it over to the ingenious, multi-bladed, carving machine.

Of course, an assembly of such devices with the computer to control them and to carry out the calculations necessary for the programming of the whole procedure would probably cost several hundred thousand dollars, a high price for even the perfectly cooked chicken. On the other hand, if one planned to go into mass cooking of chickens, over the long run such a system geared to a bank of stoves might be less expensive than all the personnel, standard equipment, and errors inevitably a part of the conventional use of conventional, "non-thinking" stoves and human cooks and kitchen help. This points to one quality of automation: it seems to require truly mass production to be economically feasible. This in turn is one important determinant of the speed with which automated equipment will appear, not in our kitchens (thank heavens!), but in our factories and offices.

III. "JOBS WANTED—HUMAN BEINGS"

Whether or not the machinery represented by the term "automation" can "really think," it does the work which formerly occupied the hands and minds of many human beings. A record company turns out eight times as much production with one-sixtieth the production workers required by non-automated equipment. A giant wholesaling firm using ten women and a computer maintains an accounting of its inventory which lags only a few hours behind the actual purchases and sales, while before by standard methods 150 tally clerks usually lagged from one to several days behind the complete transactions of the company. Before Ford installed its automated engine plant, 39 production men at 29 different machines drilled the oil holes in the crankshafts. Today this job requires nine operatives at three pieces of machinery.

An electric plant is in the process of reducing its clerical forces by over two-thirds, and a bank has cut its accounting department by nearly three-fourths. A television company which automated the assembly of much of the TV chassis it produces uses 23 machines to do what was once the tedious work of hundreds of female operatives. In the oil industry, a pioneer of automatic controls, production has gone up substantially in the post-World-War-II period, but employment has declined. From 1947 through 1952 the productivity of the electronics industry increased more than 6 times as much as its employment increase.

Will Automation Increase Unemployment?

Do these facts mean that we are facing a rapid increase in unemployment because of the technological revolution now under way? In 1952, when I was working in a steel mill in Gary, Indiana, a fellow employee who had long been at that factory showed me a gigantic complex of mainly automatic machinery called the "continuous annealer," used to heat and cool metal. A block long and towering over fifty feet above us, it looked like something out of science fiction. If eventually used to handle all the annealing of sheet steel in the country, it would cut by at least one-half the number of employees required for that one operation. "There," said my friend, "is the six-hour day or one damned big depression!"

My friend has many supporters among the experts who have been concerned about the impact of automation. Gabriel Kolko, who for several years studied the economic effects of automation, has warned that "the unemployment it causes will be, given our present frame of economic thought, very large, permanent, and absolutely unprecedented in the magnitude of its effects." Robert Bendiner, a knowlegeable journalist who examined the attitudes of management, labor, and research leaders toward automation, declared that "our present frame of thought" may have to be altered with respect to the length of the working day, the education and technical training for factory workers, and the responsibility that government should assume for both the economic welfare and the retraining of displaced workers if we are to avoid the kinds of disastrous effects of technological change that came with the "first industrial revolution."

The worried outlook of the rank and file steelworker who showed me the continuous annealer was expressed in more vivid rhetoric by the United Auto Workers, CIO, at its 1953 convention, when it declared that the new devices developed by automation, if

> . . . properly used . . . can advance by many years the realization in America of man's age-old dream of an economy of abundance. Improperly used, for narrow and selfish purposes, they can create a social and economic nightmare in which men walk idle and hungry—made obsolete as producers because the mechanical monsters around them cannot replace them as consumers.

As early as 1950, Norbert Weiner, the famous mathematician whose work has contributed so much to the development of automation, was pessimistically predicting the nightmare. By 1955, Weiner confessed to being "less fearful . . . less pessimistic," and was more concerned with the potential dangers of the transition than with the possibility of a cataclysmic crash.

Dr. Walter S. Buckingham, an associate professor of industrial management at the Georgia Institute of Technology, has tempered warnings about this transition with an optimistic view of the long-run impact of automation on job possibilities. But he, too, has warned against repeating the mistakes of the "first industrial revolution." Such restrained anticipation of a better future characterizes many of that minority of workers who have thought much about the subject.

On the other hand, the National Association of Manufacturers has called for the worker to proceed into the future "with hope in his heart." "Automation," one of its pamphlets has it, "is a magical key to creation . . . and the worker's talent and skill will continue to merit reward in the fairlyland of the world to come."

Peter Drucker, the well-known business consultant and economist, considers automation one means of overcoming a shortage of industrial workers he anticipates in the future, rather than the source of unemployment. (Recently, he has issued some warnings that automation will cause a "failure" unless revised business techniques create a market for the massive and standardized flow of goods from automated equipment.)

General Electric, which both produces and uses devices of the new technology, took somewhat the same line in a nation-wide advertisement in the summer of 1955, predicting that, in nine years, "potential customer demand" would be up forty percent, while the available industrial work force would have increased only thirteen percent in that time.

Back in 1952, the year I looked at the continuous annealer with my worried fellow-worker, Dr. Richard Meier of the planning department of the University of Chicago anticipated a job displacement of no more than one-half percent per year for the succeeding decade. While it would be hard on the three-and-a-half to four-and-a-half million employees knocked out of their jobs during those ten years, the economy as a whole, in terms of its over-all national functioning, he believes, could still be in good shape.

John Diebold, editor of *Automatic Control,* is among the cheeriest of those who publicly take a cheerful view of automation. Diebold believes that loss of jobs to machines has not been serious so far and will not be a critical matter in the future, because of our "expanding economy." He is in full agreement with Roger N. Blough, chairman of the board of the United States Steel Corporation, who believes that industrial research of all kinds inevitably produces more jobs by creating ways of producing more and better goods more cheaply.

What Is Automation

One of the prime reasons for the different points of view as to how automation will affect unemployment is the different definitions of "automation." A narrow definition, such as is used by many economists and engineers, requires the combination and integration of once-separate manufacturing processes, the use of servomechanisms and feedback control devices, to the end that a major segment of production proceeds without interruption and the materials are "untouched by human hands," and, finally, the utilization of electronic computers to control the whole assemblage of machinery. Others, among them executives and union leaders in the automobile industry, tend to collect under the automation label any machine which replaces a human hand or mind. From this point of view, the automatic chicken-carver by itself would be an example. It would not be necessary to have machinery that processed the chicken from the freezer to the carver. Obviously, the more technological changes included within the limits of automation, the more workers will be affected.

The Roots of Automation—The Feedback and Annealer

The disagreement about the proper boundaries to this new technology is more than a product of ulterior propagandistic motives or picayune quibbling. It reflects the particular way in which the devices now so dramatically commanding the public attention developed over the past three decades. Except for the electronic computer, all the elements of the automatic factory have roots reaching back into the earlier years of the modern industrial era. The principle of feedback was applied in the eighteenth century in the form of a device called the twin-ball governor which kept the old steam engines from running wild if the workload were suddenly removed. Punched cards were used experimentally in the nineteenth century. The oil industry and the paper industries long ago pioneered "continuous flow" processes.

The continuous annealer, a post-World-War-II development in the steel industry, is a good example of modern, largely automatic machinery which uses electronic controls but not computers—as yet.

The steel industry also has continuous rolling mills, continuous cleaners, continuous electrolytic lines, and other such devices which could be turned over to computers.

What has happened, then, is that over several decades there has been a steady increase in various major and minor industries of self-regulating machinery, of the centralization of control of the component devices, and of the integration of the machines for continuous process production. What makes the past decade so significant, and has made "automation" an everyday word, is the break-through on the theoretical level leading to the creation of the modern computers. Not only will automation come ever more rapidly where it is already under way, but it will appear in industries that, ten years ago, would have relegated such technological change to the realm of the distant future, if not to science fiction.

We often tend to think of advances in industrial machinery as the work of men who design and install the machinery itself. While these men are essential and major contributors to technological change, its roots are in the new theories developed by the "ivory tower boys" who deal with the abstract, "impractical" frontier of human thought and conjecture about the nature of the world in which we live. When they develop a new understanding which has a wide range of both theoretical and practical applications, a major "break-through" has been scored and neither the world of the university nor the world of the factory can remain the same.

The best-known modern example of this is Albert Einstein, from whose theories about the nature of matter, developed as "pure science," we have moved in relatively short time to the hydrogen bomb, the atom-powered submarine, and atom-power-derived electricity.

The advances of automation would have been slow and limited if it had not been for the work of "pure" scientists in the fields of communications theory and mathematics, plus the pressures of the Second World War for vastly better computing and controlling devices for defense against aircraft, etc. These "pure" scientists in Britain, France and the United States were of many different national origins, including Japanese, Mexican and German.

The speed and range of its recent developments comprise one reason why many observers call automation a "second industrial revolution". The first "industrial revolution" was accompanied by the destruction of treasured skills, the brutal exploitation of laborers, and the recurrence of depressions. These effects have led many to fear that the "second industrial revolution" will also bring in its wake upheavals, unemployment and suffering for many.

But there are crucial differences as well as similarities between the inauguration of the age of automation and the long-ago dawn of the factory society it is bound to transform.

IV. "COMES THE REVOLUTION . . . "

There is an old joke about the soapbox orator of radical inclination who promises his audience of bystanders that the riches of the wealthy classes will soon be enjoyed by all. "Comes the revolution," he shouts, "*we'll* all eat strawberries and cream!" A meek-looking fellow who has stopped to listen protests that he doesn't like strawberries and cream. Glaring at him, the streetcorner spellbinder shouts back: "Comes the revolution, you'll eat strawberries and cream and like it!"

Those engineers and business entrepreneurs who have taken the insights and inventions of the scientists and have made them part of our industrial reality have very often behaved like the soapboxer, assuring the workers whose lives were so greatly affected that all was for the best even if it didn't seem that way to the "prejudiced." Many of the men who introduced into their textile factories the steam engine and the earliest of automatic machinery foresaw only a brighter future as a consequence of their handiwork. Indeed, there was nothing in the technology they utilized which in itself made inevitable the slums, the deprivation, the exhaustion and the spiritual and intellectual starvation of their employees.

To understand even superficially what happened it is necessary to dispense with the simple stereotypes that often go along with such a catchword phrase as "the industrial revolution." For it represents a very complicated series of changes in Western society which began over two centuries ago and are still under way.

The First and Second Industrial Revolutions

During the first industrial revolution, a great disruptive movement was taking place in Europe from rural to city areas, largely changes in land tenure. Those going to the city for work crowded into tenements around the factories. They had to give up their work habits as craftsmen at home and to labor under the supervision of a managerial hierarchy. Their children were forced to work long hours under tragic conditions. They were not protected by unions, by minimum wage, factory or social security legislation. Legislative measures to deal with their problems were undreamed of.

Today, the trend toward the city is a gradual one, with counter trends toward the suburbs. Instead of crowding around the plants, millions of workers live in homes far away from their jobs, and go back and forth in their cars. They have never known anything about the home industry of the craftsmen or artisans. They are protected in their jobs by trade unions, and have the benefits of unemployment insurance, old age pensions, minimum wages, child labor laws, and other forms of labor and social legislation.

Other changes are taking place—the continuous shortening of the work-week, longer vacations, earlier retirement for the old and longer periods of education for an increasing number of the young, as well as the absorption of large numbers of young men in some permanent form of military or civilian service.

Unemployment and the Two Revolutions: Is the Solution the Same?

These developments, among others, would have helped to solve many of the problems arising from the first industrial revolution. Are they sufficient to take care of the potentially massive *displacement* of workers during the initial years of the age of automation?

Take, for instance, the program of "unemployment insurance." Its purposes as originally conceived were twofold: humanitarian relief for the victims of recession, and the maintenance of some purchasing power on the part of the unemployed during a downswing in the business cycle.

The presumption behind unemployment insurance has always been that, when business "picked up," a man would be able to return to his job. It was not designed for the man whose job literally disappeared because of technological change or the geographical relocation of industry. This is among the many reasons why it has been difficult to get the legislatures to increase the amount of unemployment compensation, even though rising prices have reduced its value roughly from three-fifth to two-fifths of the average income of the workers covered.

Today an uncounted number of industrial and office workers—more than likely going in the hundreds of thousands—are "temporarily out of work" because the devices of the new technology have taken over their functions. What happens to them? Few enough find the same work as they had been doing; and, even if they do, the shadow of the robot darkens the future. What happened once not only can, but probably will, happen again. With unemployment compensation meager; with possibilities for retraining few, inadequate, and costly; with chances for moving elsewhere to an equally good job difficult, and with the need for a continuous salary to pay for the necessities and comforts of life great, most of the displaced persons must inevitably take whatever kind of job they can find in their locality.

Then, on accepting a new position, Pete or Joe, Stanley or Mike, Willie or Gregor, is no longer "unemployed." For a few days, or weeks, or months, he has been part of what the economists often call "frictional unemployment," considered by many a "normal" consequence of a free economy. But he has lost the difference between the salary earned on the old and new jobs, his seniority rights and the status which he had acquired over the years when there was a demand for his now obsolete skills. He has also lost his insurance and pension and any other accumulating benefits at the old place of work, his vacation, not to mention the new stove he was saving for, and maybe his belief that this really is a land of opportunity.

This is the problem of displacement. It is not always easy to see it in its true dimensions when it occurs in a society enjoying relatively continuous prosperity, a society which has been learning how to soften, if not avoid, the ups and downs that have in times past characterized our kind of economic organization.

Millions of workers may suffer this kind of loss year after year even while statistics indicate that productivity, gross income, and the like are high enough to justify calling the over-all economic condition "healthy."

Even if our democracy can stand the effects of automation from a narrow technically correct economic viewpoint which sees only the balancing of totals, the question is, can it afford the spiritual and psychological consequences which flow from such extensive and continuing job displacement? And need it afford the material losses for hundreds of thousands of families every year, year after year, just to enjoy the long-run fruits of the marvelous new machines of the age of automation?

My own answer to both questions would be "no". But I suspect that our historically conditioned, intensive preoccupation with unemployment may cause us to focus our energies and imaginations upon solving the problems created by the "first" rather than by the "second" industrial revolution. As a society which has maintained for a remarkable length of time a high level of economic activity, and which enjoys an amazing degree of abundance while still on the threshold of an age of fantastically greater productivity, we are both morally and economically obligated to avoid the past practice of paying for progress by penalizing the workers.

And the consequences of automation can be challenging, exciting and satisfying to millions if they are given adequate chances. They must have financial support for retraining, for geographical mobility, and for good living standards while seeking a decent new job; if provisions are made for the safeguarding of their acquired seniority, their pension and insurance interests, their status and self-respect as skilled workers; if, in other words, a program is developed for meeting the problems of displacement rather than unemployment, the problems of the second rather than the first industrial revolution.

Whether or not we, as a nation, can shake off our thinking, adjusted as it was to the age of scarcity rather than the age of abundance, remains to be seen. It is hopeful, I think, that some of the more conservative economists are seeking to make such a transition. Peter Drucker told a management conference recently that the burden of business adjustment must pass from changes in production to marketing, since automation brings a heavy, continuous, and comparatively rigid flow of products. It remains to be seen if he and other economists will take the next step in the logic of this line of thought and admit that the crucial problem in the modern industrial economy is, in a sense, to adjust demand to supply; that, in an age of gigantic mass-production factories, consuming power must be maintained at a level which will make it possible for the consumer to buy the ever-increasing outpouring of goods from the industrial cornucopia.

The Trade Unions Present a Program

On the whole, the trade unions have made a sounder approach to this problem than the public is led to believe. In its excellent pamphlet on Automation published in 1955, the CIO's Committee on Economic Policy emphasized displacement as well as the possibility of conventional unemployment. It called for both private and governmental investigations to answer some of the following questions of the kind which deserve widespread and constant repetition:

> Will management be sufficiently social-minded . . . carefully to plan for the introduction of automation so as to minimize the job and income losses of its employees?

> Will management meet with organized labor around the bargaining table, in good faith, to work out solutions that arise from the introduction of the new technology?
>
> Will it be necessary . . . substantially to revise seniority provisions in collective bargaining contracts?
>
> How great will be the required changes in wage structures?
>
> . . . . how will society, in general, and the various levels of government in particular, meet the need to train workers for new and complex skills?
>
> Will vocational training facilities be expanded sufficiently to enable adult workers to acquire new skills, as well as to train the youths for responsibilities in automated plants and offices?

The most alert and active unions, such as the United Auto Workers, have already brought the problems of seniority, wage rates, job descriptions, and retraining into their negotiations with a number of companies. The drive for a guaranteed annual wage is intended, in part, to make the economic "cushion" for displacement more adequate. The UAW also is exploring the possibility of industry-wide seniority and preferential hiring within a given area for displaced workers.

Several AFL unions also have started bargaining for means to ease the impact of technological change on workers, concentrating on "conversion" pay to give the employee a "stake" while he seeks out a new job. But most labor organizations so far have only discussed automation and what they might do about it if and when many of their members are replaced by the ingenious devices now appearing in factories and offices. For many years the United Steelworkers of America has tended to "roll with the punch" and let the local unions handle problems of displacement in accordance with their own particular contract provisions for job rights, seniority, layoffs, and the like. They have generally been satisfied with the continued rise of wages and employment in the steel industry.

No one policy for all unions can be recommended without qualification for all unions. And the process of pioneering the proper pathways to the more abundant society that automation seems to promise is slow and difficult. It involves not only the task of haggling and bargaining between union leaders and corporation managers, but also of lobbying for and against certain kinds of legislation, of influencing bureaucratic administrations, of appealing for revised judicial thinking, of altering long and widely held attitudes; in other words, all the time-consuming tasks of a free people engaged in the solution of basic problems. In the past, however, technological change has not always proceeded at so genteel a pace as was most accommodating to the ways and means of a democratic nation.

V. THE UNMECHANICAL MEN

It is a risky pastime to predict the rate of growth of automation. The reason for this is that it is still uncertain as to whether certain industries will be subject to any considerable degree of automation. John Diebold, for example, feels that this development will play a minor part in agriculture, the professions, most of the transportation fields, much of construction, retail salesmanship, and the individualized services engaged in by barbers, locksmiths, repairmen, gardeners, and the like. Not counting the armed forces, these categories take in slightly more than half the total work force.

Automation in Transportation

However, many contend that automation will make considerable impact in a number of these fields. In transportation, for example, Corwin Mocine, an Oakland, California, city planning engineer, foresees computer-based control systems applied to municipal rapid transit. Trains on separated grades could be operated from a central station with a computer in a manner similar to the control of the elevators in some of the newest skyscrapers. In such an office building the entire set of pushbutton elevators is run as a unit by electronic controls. These controls take into account the desired destinations of all the passengers and they revise the stops of each elevator from moment to moment, to the end that everyone waiting for a ride will be able to board an elevator as soon as possible, while each passenger will reach his destination with the least possible delay. The elevators have neither operators nor dispatchers.

We can look forward also to increased automation of both flight and passenger service operations in the airlines and to such innovations as "moving sidewalks" for certain types of short-range, standardized hauling. Such a system has been proposed in Ohio for moving ore and coal in opposite directions over distances of 125 miles. This same procedure can be applied to the movement of agricultural produce from centralized receiving points to processing plants.

On the railroads, automation has already made its initial appearances in partially developed form. Centralized Traffic Control for handling from one place the routing and speeds of trains on a selected strip of single track with sidings is one instance.

Effects on Other Types of Technology

Few experts have attempted to grapple with the problem of the interaction between automation and other kinds of technological change. Generally speaking, automation seems to have served to stimulate and hasten other technological developments in two ways. First, it has brought about the creation of instruments and machines which otherwise would not now have been available. Second, it has stimulated a widespread review of work flow, productive processes, and product design on the part of companies considering the application of automation to their plants. Even where this has not led to extensive automating of the plant, it often produced alteration and refinement of equipment along other lines. In almost every case the resulting improvements lean to fewer employees and greater productivity.

The use of automation in some industries has tempted a large variety of research scientists, technicians and engineers at every level of industry to try to lead their companies in this direction. These men and women are motivated by the personal challenge automation presents and by a desire for prestige and for promotion, to exploit the automation idea in all conceivable areas. Both failures and spectacular successes have resulted.

Executives are also likely to feel pressures from their sales and their labor relations departments to head in the direction of automation. There is no question but that the products of automated production lines are much more consistent in quality and average a higher quality than those produced by the best of the preceding technology. This improvement in quality is in every case a selling point, just as the installation of automated equipment has prestige value as a demonstration that this particular company is progressive, uses the latest and finest equipment, and can afford the king-size costs. And personnel managers are likely to point out that automatic machines and maintenance workers are easier to "live with" than production-line employees.

Will Development be Slow or Rapid?

Many of those who anticipate a relatively slow development have assumed that the high cost of automating a production process would slow its adoption to a "non-disruptive" pace. The tremendous savings in labor are often supplemented by a large saving in the physical space needed. The smaller requirements for labor and for space may permit movement from developed industrial areas to locations where both labor and land can be obtained more cheaply. In addition, the cost of many of the devices of automation, such as computers, has declined substantially with the increasing rate of *their* production. Favorable tax laws and the need to replace much of our machinery anyway make the heavier investment needed for automating seem less burdensome. Since World War II investment for new machines, building and land has been enormous and is continuing to rise in many industries—much of it for more automatic production.

Several financial institutions, moreover, have indicated that they plan to find ways of providing funds for smaller firms which normally could not afford the cost of the new equipment, without which they cannot continue to compete with the big corporations. Meanwhile, the increase in mergers of small firms and purchases of them by larger companies suggest that the cost of automation has already contributed to the long trend toward "bigness" in American industrial organization.

In agriculture, increased mechanization and the failure of farmers as a group to continue to enjoy their proportionate share of current American prosperity have aided the "bigness" trend and may result in the use of many automatic devices. In the field of sales service, changes in the attitudes of the human consumers may rapidly increase the possibility for more automation.

It is true that, in the past, as John Diebold suggests, Americans have wanted to examine and talk about the merchandise and to be "waited on." But catalogue merchandising, which has increased tremendously, and self-service, which has penetrated such once highly personalized fields as the meat market, both permit substantial use of automatic machinery and controls.

In many industries, the employment of automatic machinery is economically and technically feasible only when a firm produces a huge volume of standardized goods. This situation restricts automation to certain industries which not only are capable of such massive production, but which also enjoy relatively stable levels of sales and prices. Automated equipment must be run at high speed or not at all. Production schedules and costs in an automated concern are thus much more rigid than in the old-style factory.

Where Automation Is a "Natural"

Dr. Richard Meier has suggested that automation could proceed rapidly in the near future in rayon and knit goods, in chemicals and petroleum refining, in the production of certain kinds of machinery, in beverages, confectionery and bakery goods, in printing and communications, in paperboard containers, in limited-price retailing. This list would be longer if Meier had used a broad rather than a narrow and technically strict definition of automation. But he tends to minimize the impact of partial automation—of the displacement of "a ticketseller here, a dispatcher there, a machine operator somewhere else." If such devices as the continuous annealing or electrolytic lines of the steel industry are considered a form of automation, though more primitive and less complete than the examples of computer-controlled production, then certainly the impact of automation now and in the years ahead is likely to be far greater than analysts such as Diebold and Meier anticipate.

Inflexibility of Automatic Machinery

One reason why many students of automation limit its fields of effective application is that automatic machinery is comparatively inflexible. However, the degree of flexibility which can be built into self-regulating machinery may prove to be greater than many observers have believed.[1] If so, much machinery may be useful in factories that produce in small quantities. A recent experimental giant milling machine operated by instructions recorded in coded form on magnetic tape indicate possibilities in this direction.[2]

Automation on the Assembly Line

Only a few years ago many engineers felt that much assembly work was too complicated for automation to handle for a long time to come. But it has already been applied to products other than TV sets. An automated assembly line at a General Motors plant puts together the stampings, screws, gaskets, rivets and springs that make up a finished radiator cap, and then electronically inspects the products. And partial automation of assembly work which in time will be linked to form a truly automatic activity, is spreading ever more rapidly.

[1] Dr. Solomon Barkin, Director of Research, Textile Workers Union of America, is of the belief that standardized components make for flexibility, and feels that the difficulties facing the installation of automation should not be exaggerated. For his point of view see "Modern Science and Management Creating a New Industrial Revolution," in Proceedings of the 7th Annual Meeting, Industrial Relations Research Association, 1954.

[2] The basic bottleneck in its development was the problem of translating blueprint designs into these command signals. But the ingenious engineers created a 17-character "typewriter" which stamps on paper tape the information derived from parts drawings and the performance standards for the machinery. The paper tape then is fed into a computer which handles the conversion of the information into a form which is recorded under the computer's direction on the magnetic tape. With this system the "programming" for occasionally made parts can be stored easily until needed, eliminating the piling up and time-consuming use of templates, jigs, and other forms of patterns. And every time a "run" of any size is made, the product will correspond exactly to the original set-up.

Limitations

On the one hand, then, technical and human factors can combine to promote a faster development and adoption of automation than the most sanguine observers have anticipated. On the other hand, there are some limits which the most thoroughly alarmed commentators seem to ignore or to underestimate. Some of these relate to the problems of the equipment while others have to do with the "unmechanical" qualities of human beings.

One of the major un-mechanical difficulties is that many industrial operations cannot easily be expressed in the mathematical form necessary for "programming." Where a production process does not lend itself to the either-or, one-plus-one logic, it may be possible to create a new method of altering or handling the material that has the desired characteristics. The other alternative is so carefully and completely to analyze and quantify the established process that, with a bit of luck or a stroke of genius, ways can be discovered to integrate it into the automatic flow of work and materials. Either procedure requires extensive research of the most competent sort, and the second kind of effort demands brilliance, extensive resources and a reservoir of past experience from which to draw.

While it is often difficult to program an industrial process because of these resistances to the mathematical formulation, this type of difficulty is even greater in many applications of automation to the "business" side of the enterprise. This may be true even when the office has many of the qualities of a "production line." Few large and complicated office undertakings enjoy the precise definition of goals and means, the utterly right-wrong expression of each little part of the whole activity required for automation.

A few months prior to this writing, I talked with one of the engineers involved in the automating of the accounting department of a great factory. During the week preceding our conversation he had been in almost endless consultation with the head of the department as to what the managers and supervisors would like to have taken into consideration in the programming of the automatic operation. "I finally said to the boss," this engineer told me, "that what we really needed to do was to feed *him* into the computer, twenty-seven years' experience and all!"

Inadequate Research

Up to the present time, it is a rare corporation that has provided adequate facilities for the research and development that are necessary for converting to the new technology. Those industries which have created such organizations—among them automobiles, aircraft, business pharmaceuticals—have engaged and utilized a disproportionate share of the best trained, most talented scientists, research engineers and technicians. The corporations employing these technicians offer the best salaries for such personnel, conduct the most vigorous recruiting machines, communications, electronics, petroleum and chemicals, and campaigns, and now enjoy a position far ahead of most other industries as far as automation is concerned.

Shortage of Trained Personnel

The shortage of men and women who can handle the problems of "programming" industrial processes and of designing or revising the necessary machinery and production techniques, is bound to provide a brake on the rate at which American industry adopts automated devices. What is needed are persons who can look at a complex activity involving people and machines. They must then be able to imagine this activity, in a sense, as a system of communications, a flow of information from machines to machines, from men to machines and back again, and from men to men—a system and a flow of information which are reducible to mathematical expression. Such people must have not only the essential extensive formal training in engineering and mathematics, but also must have the sort of minds and imaginations which work in this way. This quality is often lacking.

If our society were an automatic factory, the feedback of this information into the total system would lead to an immediate increase in the production of the needed parts. But since we are "unmechanical men", the speed and means with which we respond to this bottleneck are not easily predictable. We have fallen behind at the high school and college levels in producing interest and expertness in mathematics. We also have tended to de-value the sort of personality which often accompanies the talents of the programmer. And the recent emphasis on "security", that has frightened some students away from this career line, will have further contributed to the shortage.

There has been some awakening to these needs in the universities—much less in the public schools. Meanwhile, we may expect the development of organizations to provide this research and engineering activity to enterprises and industries now inadequately equipped. Some such organizations are already in the field with machinery and computers. While this helps to "stretch" the work of the present personnel, it also increases even more the immediate demand.

In addition to the present shortage of those capable of programming and related technical work, there is a rapidly growing shortage of first rate maintenance workers in both mechanical and electrical fields. Automated equipment is generally more complicated, sensitive and delicate than is the older style of technology. When one part of an integrated line break down, the whole line stops. While some increase in formal training is necessary for workers servicing and repairing the new kind of production lines, especially with respect to electrical and electronic devices, experience is still the key to the development of a good maintenance man—and experience takes time to acquire.

At the steel mill where I once worked in electrical maintenance on an integrated, continuous production line, there has been an increase in the maintenance force, especially the electrical group, a decline in the average age of the maintenance personnel, and accompanied by a lower level of performance. This defect can be traced directly to lack of experience. Since management has no alternative but to endure this situation, the problem of maintenance may well help determine how rapidly some firms adopt automated equipment.

All these problems of personnel, as well as technical and financial difficulties, must be taken into consideration by business and industrial executives. Automation may in some ways encourage the movement of plants to locations where land and labor are cheaper than in the industrially developed sections. However, the difficulty of finding trained personnel and agencies capable of servicing complex mechanical and electrical equipment in less developed areas will probably slow this migration.

Another thing that management must take into account before starting an automation program is the reactions of a company's workers and of their union. Executives may fear that the launching of such a program could cause unrest and open the door to such demands as the guaranteed annual wage or retraining programs. The concern over this may cause some policy-making managers to decide to postpone their conversion to automation "until the dust settles," especially if they are making good profits with their present mode of production. On the other hand, labor unions which win a guaranteed annual wage from non-automated enterprises, often increasing the rigidity of labor costs, may be encouraging a more rapid change to more automatic production with its greater proportion of costs for equipment and its smaller costs for labor.

I have deliberately emphasized the complexities involved in determining the rate and consequences of the technological revolution through which we are living. There have already been far too many oversimplified analyses which either see the greater productivity that automation will bring to unlimited prosperity, or the displacement of workers which follows in the wake of automation leading to a vast amount of unemployment. If either type of prediction turns out to be right ten or twenty years hence, it will be more a matter of luck than of logic.

Automation—Only One Factor in Social Change

Automation is but one factor in a most complicated set of relationships which decide our economic well-being. There is a danger, I suspect, of becoming too preoccupied with automation and paying too little attention to other factors of equal or greater importance to America's economic health such as the effect on our economic security of governmental, labor and managerial policies and of the international situation. It is to be hoped that broader view of the forces determining economic well-being will prevent us from falling into the trap of thinking that a democratic community's moral responsibility to its citizens begins only when the rate of growth of automation reaches a certain percentage point, or when unemployment passes the two-and-a-half million mark.

VI. AUTOMATION AS AN ICEBERG

When the sailors of the old whaling vessels sighted an iceberg on the horizon, they knew from rich experience that what they saw above water was the least dangerous part. They knew that a ship might founder upon some part of the massive floating glacier which lay concealed below the surface of the water, even though it altered its course to avoid the visible pinnacle.

Adam Smith and others of the early analysts of modern industrialism worried mainly about the deadening intellectual effects of the monotonous and uncreative work which, in their opinion, would increasingly characterize the factory system. They failed, on the other hand, to foresee how the industrial revolution would bring in its wake the awesome misery of the city slums, the social disruption of recurring recessions and depressions, the reforming and revolutionary movements of the workers, and even the "improved" and ever more horrible modes of warfare.

The First Revolution and Manual Labor

If automation is to any degree a "second industrial revolution," we need to consider what its advent may mean for us in ways other than the immediate and obvious problems of displaced workers. Here we can only suggest some aspects of our national life which will bear watching.

One wit has recently had it that the first industrial revolution substituted the power of machines for that of men and animals, while the second will substitute machines for brains. It is true that the first industrial revolution removed the *limits* of human and animal musclepower from factory production. But far from substituting machines for men with respect to many heavy burdens, it created more arduous, back-breaking and mentally fatiguing work than had existed in any society since the use of vast numbers of slaves in the classical civilizations. It forced men to keep up with machines, to work in accordance with machine rather than human rhythms, to pull and lift and carry the necessary materials to and from the ever-demanding, ever-producing machines. The men who went down into the deadly black mines, or who toiled in the sweatshops, or came out gray and shaking from the early assembly lines, would not easily have been convinced that the machinery had liberated them.

It is only recently, especially in the past three decades, that machinery has been used to take from the back of labor the crushing physical tasks which the first hundred and fifty years of the industrial revolution had imposed. Even in the past dozen years I have worked in a steel mill where men still turned red-hot steel bars by hand while they were being rolled, and in a cardboard factory where men carried five-and six-hundred pound bundles of scrap paper on two-wheeled hand-trucks.

Slowly such jobs are disappearing. The first industrial revolution brought the vast power of steam to industry, but, until the development of the automatic stoker, the boiler's furnaces were still fed by human beings who shoveled coal all day long. The overhead crane, the forklift tractor and floor cranes, and all the marvelous machines which feedback and automatic control make possible are at last eliminating both the heaviest and the most monotonous jobs from the nation's factories.

The workers of previous generations were pitted, by and large, against the hardness of the material, whether they used their hands or pick or shovel or individual machines such as the lathe or press. There were the giants who could lift handfuls of steel sheets weighing close to two hundred pounds. There were the craftsmen with a fantastic "feel" for their equipment and what it did to the material being worked, the industrial artists whose hammers, forges and old-style lathes were massive extensions of their own hands.

These were the heroes of industrial production for nearly two centuries—the men of almost superhuman physical prowess, and the men of supreme sensitivity and intuition for controlling machinery. Yet today the hammer forge has all but disappeared. And today one occasionally can see in the mill the old man with the sagging but impressive physique of the industrial Samson—huge shoulders, great biceps; but often when he walks one can also see that he moves with a slow and painful shuffle.

The old technology created giants, even though in the end it might crush them. The workers were not separated by the tools and machines they used from the material they changed or shaped, and the directness of their contact gave them a sense of power and a personal knowledge of accomplishment. The old-timers who can open the peephole of a furnace wall, look into the molten fire, and know if the heat is of proper quality, have a kind of work experience which the youth reading a spectroscope will never know.

Automation: Mental Labor vs. Physical Prowess

In the automated mill the workers stand or sit by various key points along the whole integrated assembly of machines, which may be several thousand feet long. Lights and meters and gauges tell them what is going on within the hidden or visible working spaces of the various devices. They must be sensitive, not to the "feel" or "hardness" of the material, but to the complex inter-relationships of the machines, to the balance of function which must be maintained for continued production. Where control has been vested in a computer, the workers are there mainly to watch for its signal for assistance in effecting an adjustment the machine cannot make, in replacing a tool, or making a repair.

There will be many more maintenance workers, fewer production workers. Mental abilities will come to be valued over physical power to an even greater degree than has been true in recent decades. The most simple, repetitive jobs disappear with automation, as they are taken over by the ingenious devices and mechanisms of the line. Repairmen and machine builders will still get greasy, but the factory rapidly becomes much cleaner and much quieter with automated equipment. How will all these changes affect our concepts of industrial work? Will we have stereotypes of "factory heroes" in the new technological era—a slim "egghead," perhaps, peering through glasses at a pile of electronic schematics? Will the changing image of millwork affect the millhand's view of himself or his attitudes toward social and economic policy?

Certainly the demand created by the new kind of work for more educated production floor employees and for the particular kind of research engineer and technician already discussed may have its impact not only upon the kind of education offered in the public schools and the universities, but also upon our attitudes toward "intellectuals." A nation with the needs which ours will have in the years ahead will not be able to afford much of the anti-intellectualism, the inverted snobbishness of those who disdain "book learning," which has sometimes characterized part of our population.

Management and Labor in Automated Factory

As for managerial practices, they will be forced to continue to change. In most of the mass production industries, the unionization of workers and the enlightenment of management have ended much of the autocracy of plant supervision which characterized factory industrialism for almost two centuries, and which produced some of the worst examples of the exploitation and degradation of workers. But there are many remnants of the old managerial attitudes which automation will make untenable.

For example, most of our present-day supervisors were brought up to believe that the productivity of the plant was directly related to the physical activity of the men. This is patently untrue in automated plants where men watch panelboards and occasionally push buttons or pull levers or turn dials. Yet it pains the old-time foreman or department supervisor to see men standing around talking with one another, even though the machines continue to roar out the production. In newly automated plants the personnel on the day shifts are likely to make some pretense at activity and to some degree restrain their social inclinations. But on the night turns, when the big bosses are away from the plant and the foremen tend to keep to their offices, the workers spend more time being sociable, while waching the machinery out of the corner of their eyes, than in any other kind of activity.

In an old-style factory, upper-level supervisors ate at a special plant cafeteria or restaurant with decent decor and good food, or left the plant for a good restaurant elsewhere. Foremen ate in their offices at their desks, comfortable behind screen doors and before the breezes of their fans, or might be permitted to use the supervisors' cafeteria. But the workers ate amidst the heat and flies and factory dirt, sitting on the floor, on crude little stools made out of scraps of lumber, or upon piles of steel, or surfaces of machines, or bundles of the product wrapped for shipping. Supervisors wore clean clothes and had clean hands, but the workers' hands were soiled. Supervisors often came out of the ranks of the most skilled workers, and were vastly more skilled and knowledgeable than the great majority of workers under their command.

In an automated factory the workers are no longer so easily distinguishable from the supervisory or clerical or testing and inspection groups. Under these circumstances, the question arises as to how long it will be before they begin to ask for the elimination of some of the hangover symbols of class distinction and supervisory superiority which abounded and still are found in the factory of old technology? How will this affect labor-management relations and the concept the worker has of himself and of his work?

What About the Older Worker?

Because the nature of the work experience itself is changed by automation, some of the older workers find it especially difficult to make the change to the new technology. They have been used to keeping their attention focused upon the material, to thinking about their work in direct, simple cause-effect terms. In an automated factory they find the vast complex of machinery to which they now must attend bewildering even when their own functions are few and easy. They have to keep a set of complicated relationships in mind, relationships which must be properly maintained if the line is to keep running. This gives them a feeling of being under "heavy pressure all the time," as one fifty-year-old put it, even though they no longer have to coordinate their own movements and activity with the speed and rhythm of the machine. And many follow the example of a highly skilled worker I know of whose job had disappeared because of a new installation. This worker chose to finish his last five years before retirement as an ordinary laborer in the plant. He was unwilling to learn the routines and the manner of thinking required of the operators and tenders of the automated equipment.

For most industrial employees, old age has traditionally been a time of defeat. In the past a millhand might rise during his prime above the subsistence level which was likely to characterize his existence as a child in a large and poorly supported family. Then marriage and children, technological change, and his own declining powers would combine to drag him back to lower living standards. When he could no longer lift as much weight as during his best years, or see so well, or act so quickly, he would face demotion or unemployment. His future was likely to be a bleak one. I have seldom seen millhands more moved emotionally than when Philip Murray, during the 1952 steel strike for pensions, told a huge rally that the companies had no right to "use up" a workingman as if he were a mechanical device to be cast onto the junk heap when it wore out.

Automation and a Lower Retirement Age

As automation increases, the rate of displacement at which older and sometimes less adaptable workers will proportionately increase and with that increase will grow an intense desire for lower retirement age and substantially larger pensions. Among the many workers of all ages whom I have known there is an almost unanimous opinion that the proper age for retirement is fifty-five, and a great many of them think fifty would not be at all too low for a man who started in the mill when he was seventeen or eighteen years old—or younger.

"You work your life out in the mill," has been a typical remark, "and when there's just about nothing left of you, you can retire!"

Old Age as an Opportunity

With the help of the union and the gains it has won for him, the worker's image of himself is changing. He is beginning to see old age as a time of opportunity rather than a period of defeat and rapid decline into austerity, if not actual poverty, and death. As a result he may greet automation, not with the stoic fatalism or unavailing gestures of sabotage of times past, but with demands for guaranteed wages, for retraining, for earlier retirement. Where a labor surplus exists for any length of time, he will demand the three-day weekend, the shorter working day, the longer vacation. These are things which the workers already want and intend eventually to get regardless of whether automation places new obstacles before them or provides a good lever for bargaining purposes.

A Possible Reversal

However, as such aims are achieved with the spread of automation, there may be a reversal of the tendency towards ever earlier retirement. The next generation of older workers, who are likely to be better adapted to the new modes of production and more flexible in their skills, will not face sudden obsolescence; and the qualities most needed among workers in the automated plant—responsibility, experience, know-how—diminish least, if at all, as the employee grows older. Such workers could stay at their jobs far past the present age of retirement without loss of status or efficiency. Today many of their goals appear to be achievable only as alternatives to a full-time factory job: to be able to engage in other vocations and avocations, travel and see something of the world, hunt and fish and take part in other leisure-time activities. Under an automated industry they may be able to attain these goals while still an employee of a factory. They may prefer not to retire but to continue their job, with its salary, with the continued enjoyment of the fellowship of an ever more easy-going shop life, and with the sense of power coming from a feeling that one is a part of the massive processes of industrial production. Instead of giving the younger workers a "chance" by getting off the top of the ladder at an earlier age, the older workers—a substantial power in the unions and in political organizations—might well demand more educational opportunities for their children—opportunities which would delay their sons' entrance into the labor market.

Retraining Programs

The establishment of retraining programs as automation advances also can have an important impact on factory life. Traditionally in most industries the worker is given a "fair shake" at a new position, a formal or informal probationary period during which, with the aid of his fellow workers, he masters the new skills while doing the job. Usually he has had some previous experience on the job, perhaps as a relief man or a replacement for someone who was sick. Most "on-the-job" training programs have only extended, formalized and supplemented this traditional system by brief instructions on the operational routines the new employee expects to assume. They presuppose that the new job calls only for additions to established techniques and skills, not for whole new attitudes toward work, whole new conceptions of machinery and of processes of production.

The old system carries with it the stereotyped conviction that "you can't teach old dogs new tricks." Because of it, relatively few men have switched from maintenance to production, or from electrical to mechanical maintenance, or from fabrication to assembly, even in the same mill. But even meager retraining programs have been quite successful in enabling some older as well as younger workers to switch to jobs in the new technology. Just as some of them can't stand the pressure" or "can't seem to get the hang of it," others report enjoying the lesser physical burdens of the new kind of work. They enjoy the freedom of not being tied so closely to the machine and the greater spirit and energy which they have when the shift is over. May not more and more workers in the future come increasingly to the belief that the old idea of confining their industrial career to a few job choices should be abandoned, and that, with the development of retraining programs, they should feel free to shift to widely varying types of jobs?

Automation unquestionably favors the younger men with more education, especially those with some college or technical school background. Retraining programs, however, may often serve the purpose of giving to older men with seniority claims to the top jobs, some of the formal and technical understanding possessed by youths many rungs below them.

Effect on Worker Innovations

This growing emphasis on education and formal training may further diminish the respect we have for experience-based knowledge. Most people outside of industry, and even many of the executives and engineers within its ranks, are unaware of the extent to which "tinkering" by maintenance and production employees has contributed to the success of a great many installations of new or modified machinery.

While the gap between "theory" and "practice" has aften been exaggerated, especially in view of the advances in the science and art of industrial design, that gap does exist and can be very significant even if it is quite small. New machinery often does not perform in little but consequential ways as the engineers expected. For a variety of reasons the workers, who may be losing bonus pay because of this, are often reluctant to "call in the brass" and the engineers and instead may experiment with modifications of the equipment or the way it is used. They do this on afternoon or night turns when the "big boys" have left the plant. Frequently they have the tacit consent or actual cooperation of the foreman or department supervisors, but usually they tell no one higher up even when successful. ("Should we tell the big boss?" "Naw, let sleeping dogs lie!")

This practice accounts for some of the "leakage" of parts and materials which almost every plant is forever trying to cut down. Whenever successful, such rank and file innovations give the men great pleasure, making them feel less dominated by the massive machinery or the professional engineers. Because of these little secret contributions to the construction and operation of machinery, one finds again and again that the machine is running well above the performance standards set by those who designed it and supervised its installation.

But secrecy and automation are enemies. The programming of a production process requires unusually complete information about both machinery and action. Once the process has been programmed, the machinery must not be altered in any way affecting performance without taking account of this in the programming—unless through the feedback within the system itself the computer and the machinery can make their own adjustment. As a result, it is often argued that automation will diminish rank and file invention with the consequences for both morale and productivity.

As far as productivity is concerned, some argue that automation so increases both the quantity and quality of production that the loss of the small increments resulting from this secret or semi-secret worker innovation is a matter of no concern. With great confidence in the near-omniscience of the design engineers, others have told me that those who create the machinery have increasingly taken into account in their planning and construction this undercover tinkering and its results. Finally, I have been told that the workers will still be able to assert their initiative and ingenuity in ways which, because they are secret, have not yet become apparent.

In support of this last view are the first complaints about "restriction of production" in automated factories. Executives of one plant in the automobile industry complained to union officials that, during negotiations over some complaints by the workers, the automatic machinery ran more slowly and with more stoppages than was normally the case. Yet they could find no evidence that anyone had tampered with the machinery in any way. "Perhaps," suggested one union official, "the boys put a hex on it."

Advocates of automation feel that in many instances it increases productivity by helping to reveal duplicate and waste effort below the policy-making level. The job of "programming" requires more precise and detailed definitions of work performance than have normally been developed, and reveals the use of orders and directives which are ambiguous and vague. A firm may find that directives from different upper level executives may seem to have contradictory meanings. It may discover that the flow of information upward has been partially blocked and distorted by employees seeking to please or impress or fool the "big bosses."

But these "blockages" or "cleaveages" in the flow of communications in a pre-automation bureaucratic business organization result not only in some decrease in efficiency, but also in a remarkable increase in the effectiveness of the most energetic and creative employees—especially those in lower administrative positions. Such men and women with imagination and initiative have opportunities to make use of talents which a perfect flow of information might well confine to the point of atrophy so far as the job is concerned. These inadvertent opportunities to be creative sometimes give future upper level executives a chance to educate, exercise and display their abilities. Instead, the computer-controlled office system will handle much of the collation, digestion and simple interpretation of information which in the past have comprised much of the work of some minor executives. While relieving office workers of many of the most boring and pressure-loaded duties (and in numerous cases of their jobs, too), the question arises as to what other kinds of indirect changes automation will bring to office life generally and to the selection and training of executive personnel in particular.

Why Automation Is the "Second Revolution"

If the development of automation meant no more than the changes in the life of the worker described above, it could be referred to as a "second industrial revolution." The essence of this new revolutionary development clearly lies in the tremendous increase in the quantity and and quality of information which it produces and the speed and accuracy of communications which it permits. What has already been called the "first industrial revolution" was a combination of great strides forward in power though the use of steam, and in machinery, especially in the field of textiles. Each of these devolopments has continued through rapid evolution and discovery to produce, on the one hand, electrical, internal combustion, and atomic and solar energy forms of power; and, on the other hand, the fabricating machines, the printing presses, the tools such as lathes and milling machines—all of which have now reached such fantastic size and complexity. The field of biochemistry is crucial to the development of plastics, fuels, farm products, medical supplies and many processes used in creating other kinds of products.

The three lines of development—power, mechanics and biochemistry—have often overlapped and have always been to some degree interdependent. Yet in application they have often remained essentially separate. Automation permits us to integrate other techniques and devices of these three developments, as in the manufacture of tinplate where today coils of steel run through the continuous electrolytic line at eight hundred feet per minute.

The increased amount and flow of communications made possible within the factory by the ability to carry the necessary information with the rapidity and accuracy among the component devices and to and from the people who supervised the operations—permits development of ever more extended integrative machinery. But its effects within the society generally are not yet clear. Already the computers work day and night solving scientific problems which were all but prohibitive in the past in terms of the man-hours of labor they would require. Automated equipment is rapidly increasing the quality and availability of the instruments of communication on which we all depend—the telegraph, telephone, radio and television which are part of automation's own ancestry in the revolution in human communications and physical transportation. The student of automation is asking, What impact will all this have on the patterns of our national life—on our behavior as consumers, on notions of what is public and what private, on esthetics, on techniques of mass propaganda and manipulation? It is a truism that "the world is getting smaller" as a consequence of technological change; but automation and its by-products tend to shift the emphasis from getting some place else to knowing in detail and almost instantaneously *what is going on* some place else.

There are other effects automation on life outside the factory and office walls which will need close observation and adequate discussion. Of vital importance are the answers to the questions: What are the consequences of a sudden rapid increase in the quality of goods and services such as automation brings? What are the consequences for the economy generally of a system in which more and more factories must run full blast or not at all? Will automation further increase our tendency to standardize and produce in mass the material stuff of our lives?

Automation and Individualized Product

There is some evidence now of an expanded demand in our society for the customized, the individualized product. Although it is very small, the percentage of custom-made cars have been increasing every year, and so have the number of mass-produced cars individualized by "hot rodders." There has been a noticeable revival of the cabinet-making craft using plastics and plywoods to create unique kitchen cabinets, hi-fi sets, and recreation rooms for people living, in many cases, in more or less mass-produced homes. "Do it yourself," which sometimes is as costly or more costly than buying "it," is another means by which greater individuality is being brought into the artifacts of everyday existence.

Will automation threaten this trend toward more variety in products and more individuality in possessions, or can it facilitate it by providing high-quality standardized units as the foundation upon which to construct the customized superstructure? Which way, in these terms, should the small manufacturer jump? Should he try to compete with the big fellow by automating his production, too, *if* it is financially possible to do so and *if* he can obtain the necessary personnel and research? Or could he latch on to the trend in our consumption patterns toward the more individualized product and even act to facilitate that trend in order to keep his market and his place in the economic sun?

The dangers of displacement and unemployment and their possible contributions to a recession loom up at us whenever the subject of automation arises. But we will need answers to these other kinds of questions, too, which may be more difficult in their implications than the problem of creating adequately paying jobs. To analyze and answer them successfully, we will need, it is true, the increased quantity and quality of information which automation brings and the fantastic problem-solving facilities of the computers. We will also need, however, a degree of imagination and skilled experimentation on the part of leaders in every phase of our life that has seldom been demanded before. Like the programmers of future office and industrial activities, we will have to learn to pay more attention to what in the past has been hidden or taken for granted.

VII. "WHAT TO DO ABOUT IT . . . "

Sometimes it seems as if automation ranks next to the weather as a subject about which everyone talks but no one can do anything. Something, of course, has been done about it in the important area of contract negotiations in unionized industries. But little outside of this area. The present situation, however, cannot remain as it is for long. We are a great nation for "doing something about it," whatever the "it" may be. A strong sense of fatalism is not part of our national heritage. The energy and exuberance which our particular history has developed in us, combined with an almost irrational belief that men can control their own destinies, have produced an ever-increasing determination to succeed in shaping the course of events to our own desires. Indeed, the recent attempts at rainmaking are undoubtedly only the first of our efforts to control the weather, too.

But, with respect to automation, little in the way of concrete proposals has come from sources outside the labor movement. There have been many very general suggestions, of course: adequate retraining programs, a sense of responsibility on the part of all concerned, government investigations, at least the minimum planning necessary to ease the transition, faith in the future. Usually lacking, however, is a detailed indication as to just what such happy phrases mean.

The following proposals are not necessarily good ones (I am certain, knowing something of my own limitations, that they are far from being really good). They are, however, intended to illustrate a way of thinking about the consequences of the new technology and the means of dealing with them.

The Need for Displacement Insurance

As I have already indicated, I believe we should distinguish between "unemployment" of the sort which results from recessions, and the "displacement" which technological change can bring even when the economy is functioning in high gear. I would like to see interested groups begin to work for "displacement insurance" as well as increases in the benefits from "*unemployment* insurance." An employee would qualify for unemployment insurance when "laid off"—when a decline in the employer's business results in what he and the employer consider a temporary termination of his job and paycheck. As is now the case, but with improvements, he would receive payments to enable him to maintain himself and his family until called back to his old position, resuming not only the job but also the seniority, vacations, pensions and other fringe benefits which generally go with it in proportion to his length of service.

The worker should be able to qualify for *displacement* insurance when his job literally had disappeared from the plant, never to be seen again no matter what the level of the company's business or the state of the nation's economy. Allotments under such a program would help cover the costs of retraining; the expense of changing to another company, if this were necessary, plus the minimum expenses of living until the new work commenced.

How Displacement Insurance Should be Financed

Displacement insurance should be financed in much the same way as the present unemployment compensation, thereby providing some additional incentive to manufacturers and business executives to introduce the new technology at such a rate as to minimize employee displacement. Indeed, if the amount of displacement is as small as the sanguine anticipate, we could well afford an adequate displacement insurance program for the moral and psychological consequences it would have. And if the amount of displacement is anywhere near as high as the fearful predict, if our economy is to survive, we will desperately need a program specifically planned to meet the problems of vanishing jobs.

Displacement insurance, like unemployment compensation, should not seek to pay the entire cost to the worker. The men and women I have known in the mills are quite willing to shoulder some of the expense of ushering in, through technological change, an era of even greater abundance for their children. Indeed, they would be delighted to have for the first time in history to carry only their share of the burden instead of almost all of it. Displacement insurance should provide compensation according to several flexible alternative formulas, with a view of better fitting the needs of the individual.

Retraining

We should begin now at least to assess the retraining facilities available in each community—social agencies, public and private schools and voluntary associations, including, of course, the unions which often could afford to run their own programs. There is no reason why the vocational training facilities of the schools should not be used in the evenings for adult education oriented to retraining the workers who have been displaced or are about to be displaced. Such use of the schools and their equipment could well be paid for partly by the industries and unions affected, and partly by the participants.

One very salutory effect of such a use of the schools is the probable effect it would have on the vocational training programs now offered to regular high school students. Almost all of these programs prepare the student with varying degrees of thoroughness and effectiveness for jobs in the factories and shops of the old technology. The public would become more aware of this lag once public school facilities and personnel begin to be used to retrain adults.

Nor should retraining programs and facilities be limited to factory work. Automation, unlike previous forms of technological change, hits the officeworker as hard as the millhand. But there are many areas of non-factory work which are rapidly expanding in our society with its increasing desire for recreation and service. Displacement could be much more to many workers than a blow which insurance and retraining would ease. It also could be an opportunity to take up a new career lines which the worker would not voluntarily seek because of intertia, accumulating benefits at the mill, and a wife, children, or other "hostages to fortune" acquired after starting in as a factory hand or office employee. The retraining program should offer at least a modicum of preparation for any form of work for which employees were needed and for which the workers could possibly qualify.

The Need for Job Information

None of this can be realized unless much more information becomes easily available about the type and location of job opportunities. Today the "want ads" and the local employment offices provide only partial information about jobs in a locale and almost nothing about opportunities farther afield.

In this field the computer can aid in supplying adequate information, thus helping to solve some of the problems that the computer has helped to create. In each state capital a computer-equipped central employment office would receive from every locality in already coded form daily reports on jobs opening and jobs filled. The computer would collate and itemize this information at least once a day and return to the local offices a complete summary. (Probably direct teletype, facsimile broadcasting or other short-wave techniques would, over the long run, be the cheapest and most effective method of distributing this information). A national employment office could provide the same service for the state agencies. In this way a local employment office could find out in a matter of hours, or perhaps even minutes, all the different job openings in a given locality or region to which a displaced worker might consider moving.

Displacement, then, would be a blow to the worker, but not such a hard one. He could more realistically choose between staying in the community where he has been employed or striking out for a new home, between seeking further use for the skills he has, or achieving new ones. For the more venturesome and energetic workers, and these certainly are not just the young ones, displacement would, in many ways, be an opportunity which, like most of us, they would seldom dare to create for themselves.

Certainly one of the great contributions of our civilization is the ideal of economic freedom—freedom in the sense of real choice, not restricted by caste lines or racial discrimination or religious prerequisites or any other kind of quality ascribed to persons without regard to merit or consent. But we have all too often failed even distantly to approximate the ideal of economic freedom for great numbers of people—frequently for a majority of the people. The recurrence of unemployment reduces choice with respect to consumption to a fiction. Lack of adequate information, adequate transportation, adequate financial means or adequate educational opportunity, similarly reduces choice of vocations to a myth that is more frustrating and dangerous the more it remains unfulfilled.

If We But Dare to Plan

As a nation we have achieved an almost unimaginable degree of geographical mobility. The revolution in communications, culminating in the computer, increases the possibilities for adequate information to an even more fantastic degree. A program for displaced workers in this age of transition to the new technology could be the beginning of a society in which the creative, the adventuring, the ambitious and energetic in every class would have real opportunity to change careers and places of residence, enriching the life and broadening the horizons of the whole society as well as of the individuals who make the changes. If we dare in this way to use the full potentialities of the new technology we are creating, we will also make a solid contribution to the maintenance of that prosperous economy without which all the rest is but daydreaming.

Of course, we are dealing here not with logical, predictable electrical and mechanical devices, but with our own unmechanical, often irrational, never wholly predictable selves. Still, why not try for the best to which we can aspire?

SOURCES OF ADDITIONAL INFORMATION ON AUTOMATION

During the past five years there have been hundreds—probably more than a thousand—features and articles and speeches on automation. Published accounts and analyses have appeared in most of the major magazines and newspapers, as well as in various professional journals of less general circulation. Space does not permit me to acknowledge even those published and unpublished accounts which have contributed directly to this pamphlet. The following references are meant only to be examples of additional sources to give the interested reader some ideas on how to obtain more information.

Probably the most complete and up-to-date list of published materials of all sorts on automation is

Source of Materials on Automation and Related Subjects

which was compiled by the Library of the UAW-CIO Research and Engineering Department and published in April, 1955. There are a number of magazines, more or less specialized and technical, which are devoted to automation, and which regularly take note of newly published materials—periodicals such as

Automatic Control; Automation; Computer and Automation; Control Engineering

and others which your local library may be able to suggest.

The Congress of Industrial Organizations, 718 Jackson Pl., Washington, D. C.) ; the National Association of Manufacturers (2 E. 48th St., N. Y. C.) , the United Auto Workers, CIO (8000 Jefferson, Detroit, Mich) , and other unions, business and management associations have prepared, usually brief and effective, materials on automation as seen from their particular viewpoints.

Many magazines have published articles on automation, and occasionally a series of articles has appeared in a magazine or newspaper, such as *Fortune* for October, 1953 (a roundtable) ; and *Saturday Review* for January, 1955; and the issues of the *Chicago Sun-Times* of March 6-10, 1955. The library can again be helpful here, but so can a regular scanning of the magazine racks and the newspapers for the latest articles which so inevitably have been and will be appearing.

There have been more technical books than books designed for more general reading, but general reading, but examples of the latter are John Diebold's *Automation* and Norbert Wiener's *The Human Use of Human Beings* (especially the revised edition published by Doubleday in an "Anchor Book" paperback format) .

By all means do not depend entirely upon published materials. Persons living near industries should feel free to seek out engineers, managers, and union leaders for information and discussions about what is happening automation-wise in that particular industry and factory. Whenever possible organizations should have experts as guest lecturers with plenty of time provided for questions and discussion.

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